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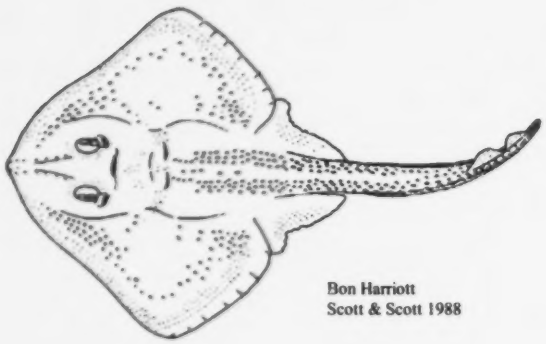
Canadian Science Advisory Secretariat
Science Advisory Report 2005/062

RECOVERY POTENTIAL ASSESSMENT FOR WINTER SKATE ON THE EASTERN SCOTIAN SHELF (NAFO DIVISION 4VW)



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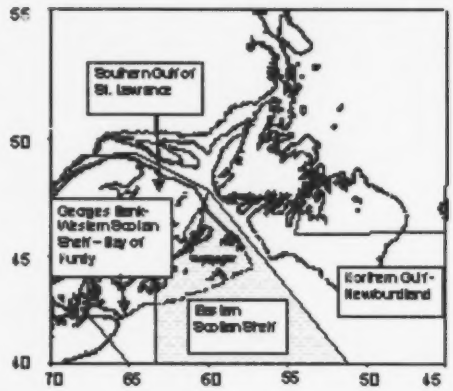

Figure 1: Area of winter skate distribution indicating 4 designatable units.

Context

In May 2005, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated winter skate (Leucoraja ocellata) on the eastern Scotian Shelf as threatened. They are currently being considered for listing in Schedule 1 of the Species at Risk Act. This designation was based on winter skate's low productivity, restricted geographic distribution, and the 90% decline in abundance of mature individuals since 1970. At this time there is a limited directed fishery. Total allowable catch (TAC) has been 200t annually since 2002. There is also fishing mortality due to bycatch in groundfish fisheries though this mortality has been reduced due to drastic reductions in fishing effort. Mortality in offshore clam and scallop fisheries remains unquantified. Winter skate have been noted in grey seal diet but the magnitude of the impact of this predation on the population is not well understood.

SUMMARY

- In May 2005, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed winter skate on the eastern Scotian Shelf as threatened. They are currently being considered for listing on Schedule 1 of the Species at Risk Act.
- Catch rates of adult winter skate (75+ cm) in the July Research Vessel (RV) survey indicate a decline of 90% since 1970. The decline appears to be ongoing and is projected to continue in the future at recent fishery removal levels.
- At the beginning of the July RV survey time series (1970s), juvenile winter skate abundance was low. Juvenile winter skate abundance increased during the 1970s. It was fairly stable in the 1980s but has been declining since the 1990s.
- There has been a directed skate fishery, catching mostly winter skate, since 1994. A progressive reduction in Total Allowable Catch has resulted in landings falling from over 2000t in the first year to less than 300t annually since 2001.

Canada

- Winter skate are caught as bycatch in many fisheries. With moratoria or dramatic reductions in effort on most groundfish fisheries on the eastern Scotian Shelf, this bycatch is estimated at less than 300t annually for the last 10 years. Bycatch since 2000 has averaged 74t.
- The offshore scallop and clam fisheries may have substantial amounts of bycatch, as seen in the US fishery on Georges Bank, however this bycatch is not recorded.
- Population models indicate an increase in adult natural mortality (or unknown sources of human-induced mortality such as unreported bycatch) in the 1980s and 1990s.
- Increased adult natural mortality occurred during a period of increasing grey seal abundance.
- At the current high rate of adult natural mortality, no recovery is expected even if reported directed and incidental catch is held to zero.
- There is little or no scope for human-induced mortality if this population is to recover and even then recovery is not certain.

BACKGROUND

Rationale for Assessment

The Species at Risk Act (SARA) provides legal protection to species listed in Schedule 1 and prohibitions under SARA would apply to eastern Scotian Shelf (ESS) winter skate if added to the list. If listed, activities that would harm the species would be prohibited and a recovery plan would be required. Until such a plan is available, section 73(2) of SARA authorizes competent Ministers to permit otherwise prohibited activities affecting a listed wildlife species, any part of its critical habitat, or the residences of its individuals.

Under section 73(2) of SARA, authorizations may only be issued if:

(a) the activity is scientific research relating to the conservation of the species and conducted by qualified persons;

(b) the activity benefits the species or is required to enhance its chance of survival in the wild; or

(c) affecting the species is incidental to the carrying out of the activity.

Section 73(3) establishes that authorizations may be issued only if the competent minister is of the opinion that:

(a) all reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted;

(b) all feasible measures will be taken to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals; and

(c) the activity will not jeopardize the survival or recovery of the species.

Decisions made on permitting of incidental harm and in support of recovery planning need to be informed by the impact of human activities on the species, alternatives and mitigation measures to these activities, and the potential for recovery. An evaluation framework, consisting of three phases (species status, scope for human–induced harm and mitigation) has been established by DFO to allow determination of whether or not SARA incidental harm permits can be issued. The analysis provided herein will inform decisions relating to the listing of winter skate and its recovery planning. In the context of this status report, "harm" refers to all prohibitions as defined in SARA.

Species Biology

Winter skate (*Leucoraja ocellata*), also known as big or eyed skate, have only been reported in the Northwest Atlantic. Their range extends from the Gulf of St. Lawrence and the southern Newfoundland coast southward to Cape Hatteras. Within this range they have been reported from waters less than 1 m in depth to 371 m. On the eastern Scotian Shelf (NAFO Division 4VW) winter skate are found predominantly on the banks. Based on survey data, they are concentrated on Sable Island Bank and northward to Middle Bank, and on Banquereau Bank. They are caught in higher numbers in winter, concentrated along the southern side of Sable Island Bank and along the Stone Fence. Members of the fishing industry have reported that it is more difficult to catch skates in summer as they move onto the banks and spread out when the water temperature increases. In winter months, winter skate tend to be in deeper waters with a more concentrated distribution. There is little information on the distribution of winter skate in the inshore area of 4VW. Winter skate and little skate (*Leucoraja erinacea*), a closely related species, are sympatric over most of their range and are difficult to distinguish, especially at lengths less than 35 cm. Maximum length is reported to be about 109 cm, while little skate grow to a maximum length of about 53 cm.

Winter skate are oviparous elasmobranchs with low fecundity and late maturity, life history characteristics that make them vulnerable to over-exploitation. In 4VsW, female winter skate begin to mature at 65 cm and 50% maturity occurs at a length of 75 cm. It is estimated that females produce fewer than 50 eggs annually. Each egg is in a horny capsule (purse) that may take as long as 22 months to hatch. Predation by gastropods (which are able to bore holes through the leathery egg capsule) is thought to be the main source of mortality during the egg-capsule stage. Length at hatching is approximately 12 cm.

On the eastern Scotian Shelf, winter skate diet is almost exclusively comprised of fishes although crustaceans, polychaetes, and molluscs are also eaten. Of the fish species consumed, over 90% by weight is sandlance based on samples collected during RV and Industry surveys. Winter skate are preyed upon by sharks, seals and other skates.

Winter skate do not have any known dwelling-place similar to a den or nest during any part of their life cycle, hence the concept of "residence" as defined in the Species at Risk Act does not apply.

Fisheries

There has been a directed skate fishery, of which most are winter skate, since 1994. A progressive reduction in total allowable catch has resulted in landings falling from over 2000t in the first year to less than 300t annually since 2001. The TAC has been set at 200t since 2002. There is also fishing mortality due to bycatch in groundfish fisheries though this mortality has been reduced due to drastic reductions in fishing effort. Bycatch has averaged 74t since 2000. Mortality in offshore clam and scallop fisheries remains unquantified.

ASSESSMENT / ANALYSIS

Stock Trends and Current Status

The main source of information used to evaluate trends in the relative abundance of winter skate on the eastern Scotian Shelf was the July RV survey, which has been conducted since

1970. Additional information was obtained from an Industry skate survey conducted each spring since 1995. For analyses, skate were grouped into three size classes: (1) 75+ cm and longer, roughly corresponding to the adult portion of the population, (2) 60-74 cm, juvenile skate that are caught at a relatively high rate in the directed skate fishery, and (3) 36-59 cm, juveniles caught at a low rate in the directed skate fishery. Winter Skate below 36 cm in length were omitted from further analysis since they are difficult to distinguish from little skate.

At the beginning of the July RV survey time series (1970s) juvenile winter skate abundance was low. Juvenile winter skate abundance increased during the 1970s, was fairly stable in the 1980s, and has been declining since the 1990s (Figure 2). Adult winter skate (75+ cm) abundance has declined since 1970 (Figure 2). The catch rates indicate a decline rate of 90% over the 35-year time series (Figure 3). This decline appears to be ongoing.

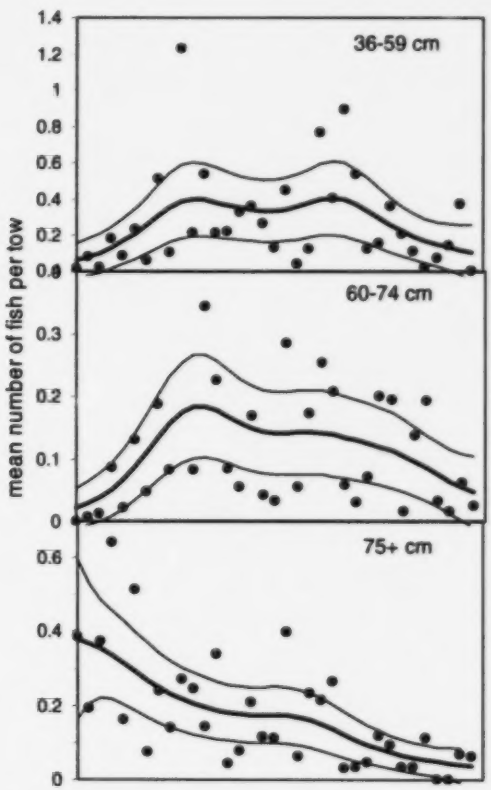

Figure 2. Catch rates of three size classes of winter skate in the July survey of the eastern Scotian Shelf. Lines show a smoothed fit to the time trend with 95% confidence intervals.

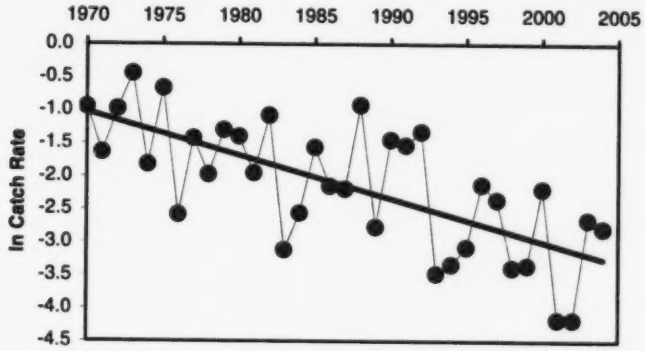

Figure 3. Log_e catch rates of adult winter skate (i.e., skate 75+ cm) in the July survey of the eastern Scotian Shelf. Zeros in 2001 and 2002 were replaced by one-half the minimum observed non-zero value before log-transformation.

A comparison of catch rates in the spring Industry skate survey and the July RV survey revealed comparable trends in winter skate biomass. In both cases, the biomass index declined from the mid 1990s to the early 2000s. The average index in the 2003-2005 period is 36% of the average for the 1995-1997 period in the case of the July RV survey, and 24% of the average for the 1995-1997 period in the case of the Industry survey (Figure 4).

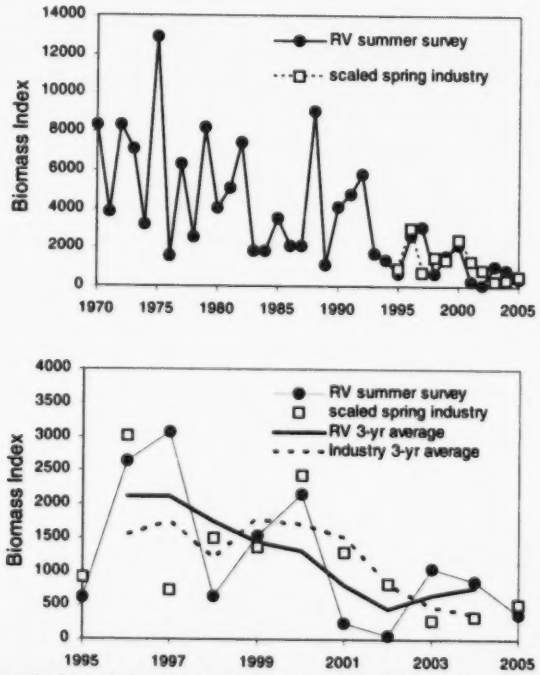

Figure 4. Comparison of trends in catch rate between the July RV and spring Industry surveys. Data from the July RV survey are restricted to strata in the area covered by the Industry survey (strata 446-458). Catch rates in the Industry survey are scaled to have the same average value as the July RV survey in the 1995-2005 period. (The average biomass index in the Industry survey was 6.8 times the average in the RV survey in the 1995-2005 period.)

Based on catchability-corrected survey data, average adult abundance in the 4VW area was estimated at approximately 5 million skates in the 1970-1974 period, and declined to 700,000 in the 2000-2004 period. There is considerable uncertainty around these estimates. Based on population models, the absolute adult abundance in the 1970-1974 period is estimated at 4.1 million (2.5 to 8.6 based on 95% credible limits) and 500,000 (206,000 to 1.1 million) in the 2000-2004 period.

Fishery Removals

To estimate the total removals of winter skate in 4VW landings information, observations of skate bycatch from various fisheries from the observer program (IOP) were examined. The species composition of skates in the July RV survey was applied to the catch records to estimate the proportion of winter skate in the catch. Foreign as well as Canadian data were included to estimate bycatch and discards of winter skate from these fisheries, as well as results from the directed fishery for skate. The primary finfish fisheries in 4VsW are halibut, redfish, flatfish and cod, haddock, and pollock (CHP). NAFO Division 4Vn was excluded from these analyses because very few winter skate were observed there in the July RV survey. Landings of each species and species group were extracted from NAFO (1970-85), ZIF (1986-2002) and MARFIS (2003-2004) databases. Observer reports where skate were caught were extracted to determine the level of bycatch of all species of skate in each fishery.

There has been a directed skate fishery, of which most are winter skate, since 1994. A progressive reduction in total allowable catch has resulted in directed landings falling from over 2000t in the first year to less than 300t annually since 2001 (Table 1). The 2005 quota is set at 200t. Winter skate are caught as bycatch in many fisheries. Following moratoria or dramatic reductions in effort on most groundfish fisheries on the eastern Scotian Shelf this bycatch is estimated at less than 300t annually in the last 10 years. Bycatch since 2000 has averaged 74t. The offshore scallop and clam fisheries may have substantial amounts of bycatch, as seen in other areas, however this bycatch is not recorded. Foreign fleets removed significant amounts of skate in earlier time periods but these removals have been less than 200t in the last 10 years and have been negligible since 2000. Total catch from 2000-2004 averaged 300t annually. This corresponds to an estimated fishing mortality of 0.1.

	Bycatch Canadian Halibut	Bycatch Canadian CHP	Bycatch Canadian Flatfish	Bycatch Canadian Redfish	Bycatch Foreign Silver Hake	Directed Canadian Skate	Total Removals
2000	4	15	31	28	1	358	437
2001	6	14	19	69	1	235	344
2002	5	7	18	42	0	278	350
2003	6	3	21	29	0	39	98
2004	6	5	10	29	0	233	283

Table 1. Total removals of winter skate in 4VsW from the directed skate fishery, the foreign silver hake fishery and bycatch of winter skate from the primary Canadian groundfish fisheries since 2000.

Mortality Trends and Possible Causes

Mortality trends and recovery potential were assessed using Bayesian state-space models. These models incorporate both observation error and the error associated with population

dynamics processes (process error), and can incorporate prior information on these processes. Stage-structured population models were used because age-disaggregated data were not available for this population. Two types of models were used. One type, referred to here as *Z* models, estimated trends in total mortality (*Z*) of juveniles and adults. Data inputs were catch rates in the July RV survey, treated as indices of relative abundance. The second type, referred to here as *M* models, estimated trends in natural mortality (*M*) and exploitation rate. Data inputs were the estimated landings, estimates of discarded bycatch and the survey abundance indices. In this case, the survey indices were scaled to absolute abundance by correcting for catchability to the survey gear. Mortality of discarded skates was assumed to be 70%.

In the *Z* models, mortality was either constrained to be constant over the time series or was allowed to vary over time, either as decadal variation or as a trend over time. These models suggested that mortality was relatively high in the 1970s for juveniles in the 36-59 cm size class and that adult mortality increased progressively from the 1970s to the 1990s (Figure 5).

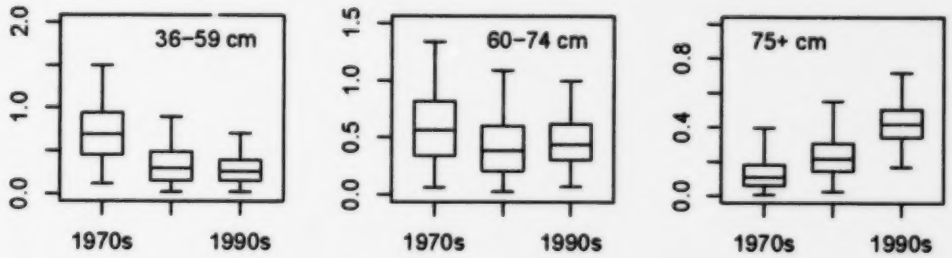

Figure 5. Estimated total mortality rate (Z) of winter skate by size class and decade. Vertical lines show the 95% credible limits, boxes the interquartile range and horizontal lines the median.

Based on the *M* models, the exploitation rate on all size classes declined in the early 1990s (Figure 6), when fishing effort in groundfisheries declined sharply. Estimated exploitation rate on the larger skates (60+ cm) increased with the start of the directed skate fishery in 1994, but declined in the late 1990s as catches in this fishery were reduced. The estimated exploitation rate on all size classes has been very low in recent years. Estimated decadal variation in *M* was similar to the variation in *Z*, with *M* decreasing from the 1970s to the 1980s for the smallest size class and increasing from the 1970s to the 1990s for mature skates (Figure 7). Models indicated a significant positive relationship between adult *M* and grey seal abundance, suggesting that increased predation by seals may be a cause of the increased adult mortality. However, seal predation is thought to be focused on small fish, but juvenile *M* and seal abundance were not positively related.

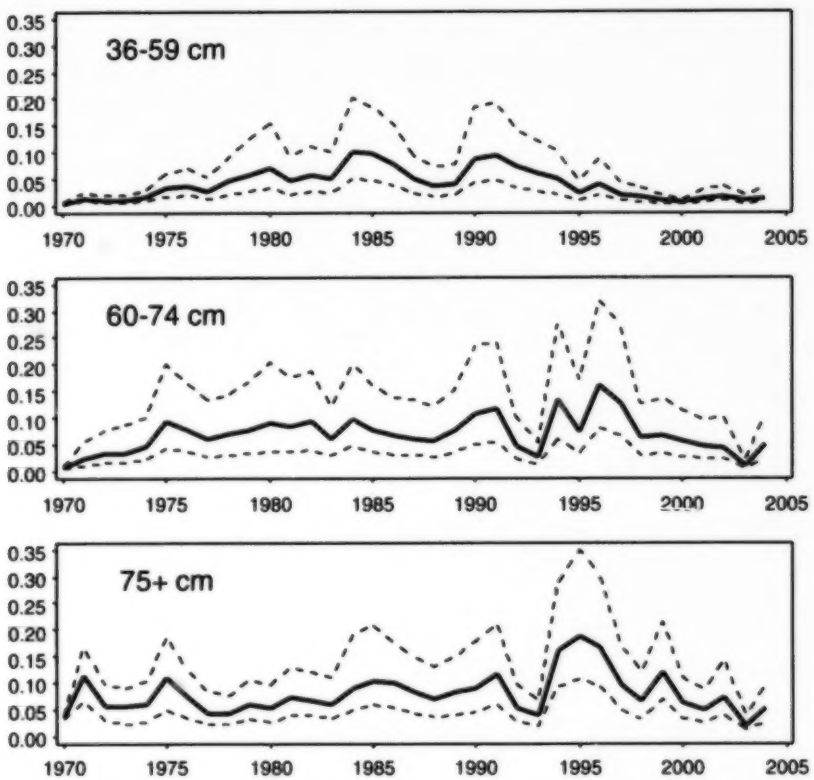

Figure 6. Estimated exploitation rate on winter skate by size class (median estimate and 95% credible limits).

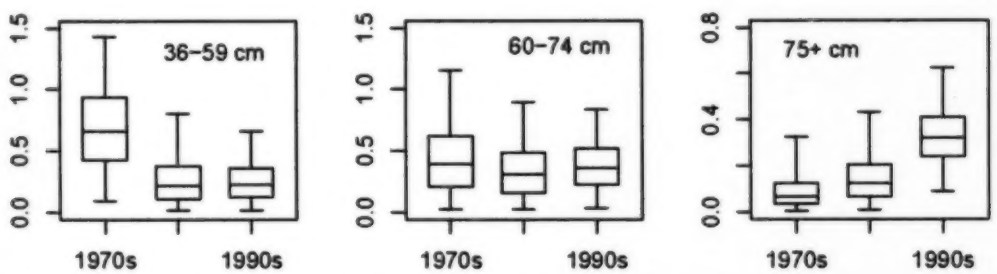

Figure 7. Estimated natural mortality rate (M) of winter skate by size class and decade. Vertical lines show the 95% credible limits, boxes the interquartile range and horizontal lines the median.

Recovery Targets

Recovery targets have not been established for winter skate on the eastern Scotian Shelf. In this stock it is not possible to estimate either unfished biomass or MSY. Potential recovery targets could be the survey catch rates observed in the 1970s or the long term mean. As the average survey catch rate for adults in 2000-2004 is 16% of the average for 1970-1974, these proposed targets would be 3- 6 times the current catch rates.

Recovery Potential

The population model was used to project population abundance 10 years into the future in order to evaluate recovery potential. Projections were based on the model with decadal variation in *M*. Future *M* was assumed to be at the 1990-2004 level. Future fishery removals were assumed to be either nil or at the 2000-2004 level (about 230t landed and 70t discarded). Bycatch in the scallop fishery was unknown and could not be incorporated in the models. The model predicts a continued decline in abundance at current levels of removal and a reduced decline or stability if removals are set at zero (Figure 8). However, the uncertainty about the projection was great and encompassed both extirpation and recovery in the 95% credible limits around the median trend. Based on the most probable trend, no recovery is expected without a decrease in adult natural mortality (or unknown human-induced mortality that is interpreted as natural mortality in the models).

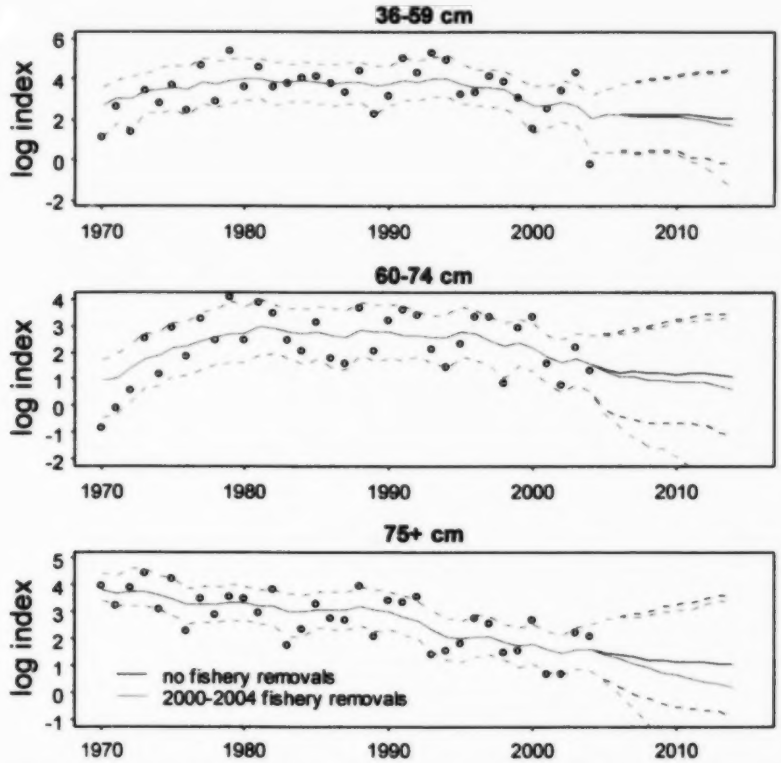

Figure 8. Projected population trajectories (median and 95% credible limits) given two different scenarios for fishery removals.

Allowable Harm

Total mortality is estimated in the model and is apportioned between natural and fishing mortality. For the purpose of the model the fishing mortality is only attributed to catches that have been quantified. Model-based estimates of adult natural mortality may include unknown sources of human-induced mortality. For example, bycatch in the scallop and offshore clam fisheries is unquantified. At the current high rate of adult natural mortality, no recovery is expected even if reported directed and incidental catch is held to zero. There is little or no

scope for human-induced mortality if this population is to recover and even then recovery is not certain.

Because an increase in *M* of adults appears to contribute to the decline in abundance, removal of the aggregate human-induced mortality may not be sufficient to allow recovery. However a portion of the apparent increase in adult *M* may be due to unaccounted sources of human-induced mortality (such as bycatch in the offshore scallop and clam fisheries).

Skate egg cases occur on the bottom for 18-22 months hence are susceptible to bottom trawling, dredging, and other bottom disturbances.

Although not a source of human-induced mortality, it should be noted that natural mortality of adults has increased over the same period that seal abundance has increased. This increase in adult natural mortality seems to be a contributing factor in the lack of recovery potential for this population.

Sources of Uncertainty

There is limited ageing information. There is no information on whether growth rates changed over the survey time period. If juvenile growth rate has declined in recent years, then adult mortality may be over-estimated in these years relative to earlier years. However, size at maturity has remained constant since the 1970s, consistent with the hypothesis that growth rate has changed little since then.

The dynamics of this population are poorly understood. For example, juvenile abundance in the 1960s and 1970s was very low relative to adult abundance. Both juvenile and adult mortality have changed over the period of investigation. This change in natural mortality is not well understood.

The magnitude of bycatch in the offshore scallop and clam fisheries is unknown. Skate are caught in significant numbers in the US scallop fishery on Georges Bank. Observer coverage is necessary to quantify the impact of these fisheries on winter skate.

The survival rate of discards is unknown but is considered to be <50%.

The potential impacts of human activities on habitat have not been evaluated.

The impact of increased predation by seals is not known but may be significant due to the exponential increase in seal abundance.

No correction for day night differences in survey catch were made in analyses of the July RV survey data in 4VW in contrast to 4T survey data where such corrections were required. These corrections can change the perception of absolute abundance.

There is inadequate information to draw any conclusions on the potential impacts of oil and gas exploration and production.

CONCLUSIONS AND ADVICE

According to July RV survey data, the abundance of adult winter skate on the eastern Scotian Shelf has declined sharply since the 1970s and has shown no sign of recovery.

There has been a directed skate fishery, of which most are winter skate, in 4VsW since 1994. The annual TAC has been set at 200t since 2002. Winter skate are caught as bycatch in many fisheries but following dramatic reductions in effort this bycatch is estimated at less than 300t annually over the last 10 years. Bycatch since 2000 has averaged 74t. The offshore scallop and clam fisheries may have substantial amounts of bycatch, however this bycatch is not recorded. Foreign fleets removed significant amounts of skate in earlier time periods but these removals have been negligible since 2000. Total catch from 2000-2004 averaged 300t. annually. This corresponds to an estimated fishing mortality of 0.1.

The decline in the abundance of winter skate appears to be caused by an increase in natural mortality. The increase in natural mortality occurred over the same period as an exponential increase in grey seal abundance. Increased seal abundance may be a contributing factor to the lack of recovery. The model used may be interpreting unknown human-induced mortality as natural mortality.

Model projections predict a continued decline in abundance at current levels of removal and a reduced decline or stability if removals are set at zero. However, the uncertainty about the projection was great and encompassed both extirpation and recovery. Based on the most probable trend, no recovery is expected without a decrease in adult natural mortality (or unknown human-induced mortality that is interpreted as natural mortality in the models). There is little or no scope for human-induced mortality if this population is to recover and even then recovery is not certain.

SOURCES OF INFORMATION

Swain, D.P., J.E. Simon, L.E. Harris, and H.P. Benoît. 2005. Recovery potential assessment of 4T and 4VW winter skate (*Leucoraja ocellata*): biology, current status and threats. DFO Can. Sci. Advis. Sec. Res. Doc. 2006/003.

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